ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 12, December 2013

INFLUENCE of PARTICLE SIZE on CITRIC ACID PRODUCTION by *Aspergillus niger* USING RICE CHAFF and SESAMUM OIL CAKE as SUBSTRATES

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Abstract: This study mainly pertains to the variations on citric acid production brought about by ETGP12 and ETGP18 strains of *Aspergillus niger* at different particle size of rice chaff and sesamum oil cake as substrates. Initially the substrates were ground and were sieved through sieves as having different sizes 2, 4 and 6 mm and substrate media of each particle size were separately used. The results showed that the yield of citric acid in ETGP12 strain of *Aspergillus niger* increased with increase in particle size as substrate up to 4 mm giving a maximum yield of 97.5 and 102.4 g/kg from sesamum oil cake and rice chaff, respectively and the yield decreased at particle sizes below 2 mm. Similar kind of observations were seen in the ETGP18 strain of *A. niger* giving a maximum of 71.3 and 76.3 g/kg yield at particle size 4 mm of sesamum oil cake and rice chaff ,respectively. It was also found that at the particle size of 2 mm , the conversion of sugar into citric acid was also observed and found less compared to the particle size of 4 mm of substrate.

Keywords: Particle size, Sesamum oil cake, Rice chaff, Fermentation, *Aspergillus niger*, Citric acid.

I.INTRODUCTION

Citric acid is a commercially important compound used in a wide range of industries right from food to pharmaceutical industry. It has an estimated annual production of about 1000,000 tons with good annual growth of demand. Recently cost effective methods like substrate surface fermentation by strain of the fungus *Aspergillus niger* have been employed. Different factors like pH , temperature, moisture, mutations, nutrients and particle size affecting citric acid production are studied separately mainly to obtain optimum conditions for maximum citric acid production. In this study sesamum oil cake and rice chaff as substrates were used as different particle size. The substrate media of each particle sizes were used to study the change in citric acid production brought about by ETGP12 and ETGP18 strains of *A niger* along with ATCC9142 strain of *A niger* as control . All these conditions were tested under substrate surface fermentation conditions.

II.MATERIALS AND METHODS

The ground substrates were sieved through sieves having different sizes, like 2, 4 and 6 mm, and substrate media of each particle size were separately used in the studies. The results of the studies pertaining to the production of citric acid from sesamum oil cake and rice chaff having different particle sizes have fermented with the strains of the *A. niger* ATCC 9142, ETGP12 and ETGP18.

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III. RESULTS DISCUSSIONS

The yield of the citric acid by *Aspergillus niger* ATCC 9142 increased as the particle size of both the substrates increased upto 4 mm, thereafter a decrease in the yield of citric acid was observed. The maximum citric acid yields were 94.8 and 102.3 g/kg observed at particle size 4 mm and the least yield of citric acid 89.5 and 93.3 g/kg were observed at the particle size 2 mm from sesamum oil cake and rice chaff wastes. Similar observations were made with the strain *A. niger* ETGP12. As the particle size of the substrates was increased to 4 mm, yield in the citric acid increased. The maximum yields of citric acid obtained were 97.5 and 102.4 g/kg from sesamum oil cake and rice chaff, respectively. The same substrates have showed less yield for the less particle size, i.e., 2 mm (82.4 & 90.2 g/kg respectively from sesamum oil cake & rice chaff). The similar kind of the observation was made from *A. niger* ETGP18. It has resulted that as the particle size increases the yield obtained was more. At the particle size of 4 mm, the yield obtained was 71.3and 76.3 g/kg from sesamum oil cake and rice chaff respectively, while the yield was less at the particle size 2 mm (48.7 and 60.3 g/kg respectively from sesamum oil cake and rice chaff) (Figs 1-7).

The decrease in the concentration of the sugars was observed as the citric acid yield increased on all the days of the fermentation of the substances of different particle sizes by all the strains. The maximum sugar conversion efficiencies of *A. niger* ATCC 9142 were 58.6 and 59.4% from sesamum oil cake and rice chaff, respectively at the particle size of 4 mm, while less at the particle size of 2 mm (45.3 & 48.4% from sesamum oil cake and rice chaff respectively). The strain *A. niger* ETGP12 has revealed that the conversion of the sugars with 70. 3 and 73.2% from sesamum oil cake and rice chaff respectively. At the particle size of 2 mm, the conversion of the sugar into citric acid was observed and found less compared to that of the particle size 4 mm (52.3 & 56.4% respectively from sesamum oil cake and rice chaff wastes). The strain *A. niger* ETGP18 has revealed that the conversion of the sugars with 71.6& 75.7% from sesamum oil cake and rice chaff respectively. At the particle size of 2 mm, the conversion of the sugar into citric acid was observed and found less, compared to that of the particle size 4 mm (65.3 & 68. 3% respectively from sesamum oil cake & rice chaff wastes).

The particle size of the substrate greatly influences the production of citric acid under solid state fermentation (Hesseltine 1972). Smaller the particle size, larger the surface area for heat and mass transfer yielding to higher nutrient concentrations and shorter nutrient diffusion pathways. On the other hand, small sizes of the particles also lead to closer packing densities and reduction in the void space lead to reduced heat transfer area and gas exchange with the surrounding media (Lansane & Ramesh 1990). Hence, agitation of the smaller particle becomes necessary to provide for a high degree of particle separation. Therefore, the particle size should not be so small that heat transfer or gaseous exchanges are hindered to a large extent that nutrient transfer is limited. Therefore, the optimum particle size needs to be studied at which maximum productivity can be obtained.

The decrease in the concentration of the sugars was observed as the citric acid yield increased on all the days of the fermentation of the substances of different particle sizes by all the strains. This clearly indicates that the different substrates have their own optimum particle size for maximum yield of citric acid.

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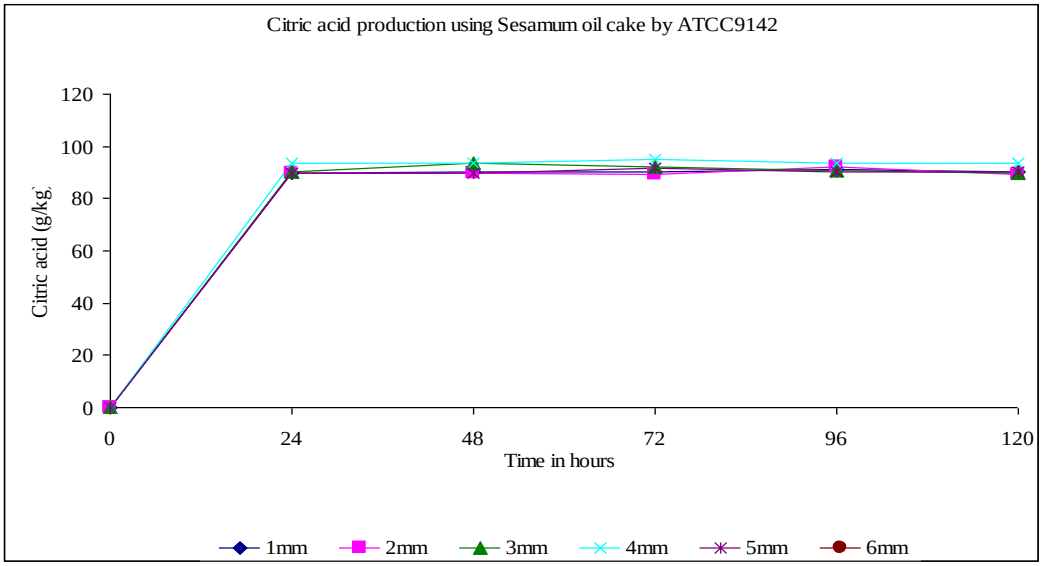

Fig.1. Production of citric acid at various particle size using Sesamum oil cake as the substrate using ATCC9142 strain.

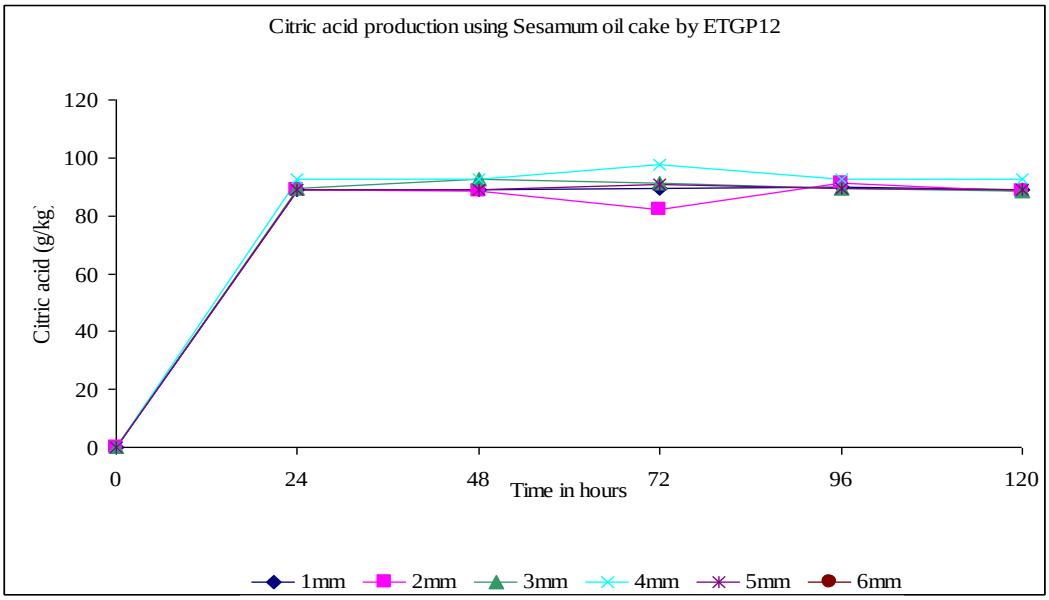

Fig. 2 Production of citric acid at various particle size using Sesamum oil cake as the substrate using ETGP12 strain.

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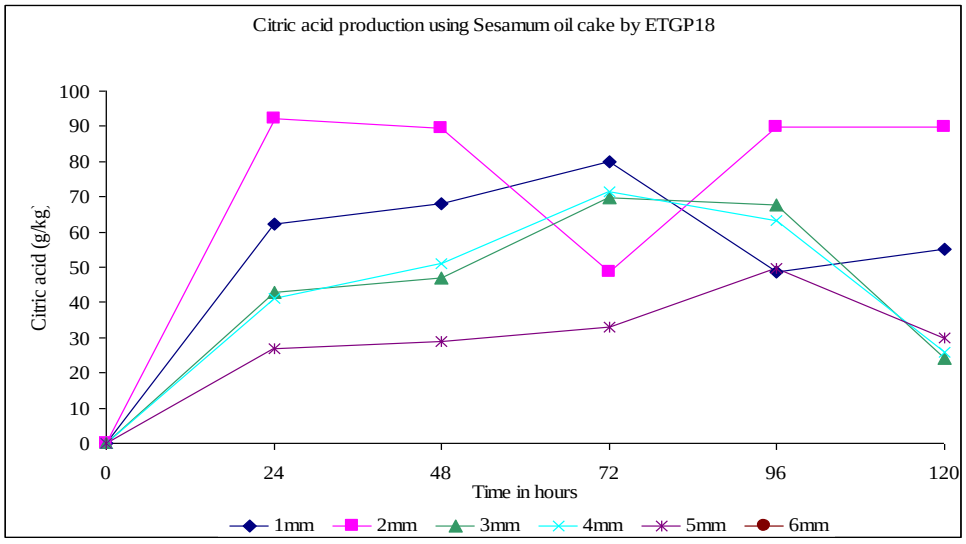

Fig.3 Production of citric acid at various particle size using Sesamum oil cake as the substrate using ETGP18

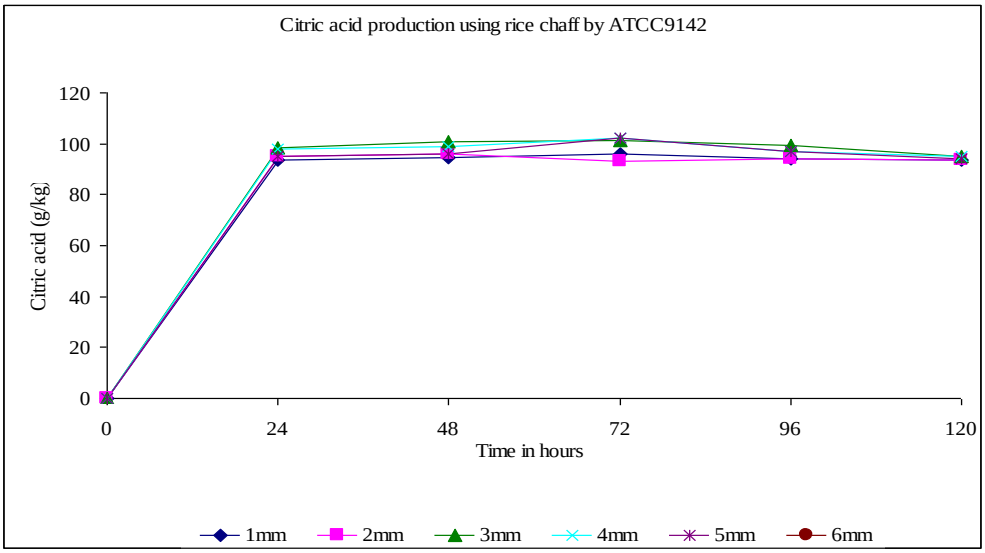

Fig.4 Production of citric acid at various particle size using rice chaff as the substrate using ATCC9142 strain.

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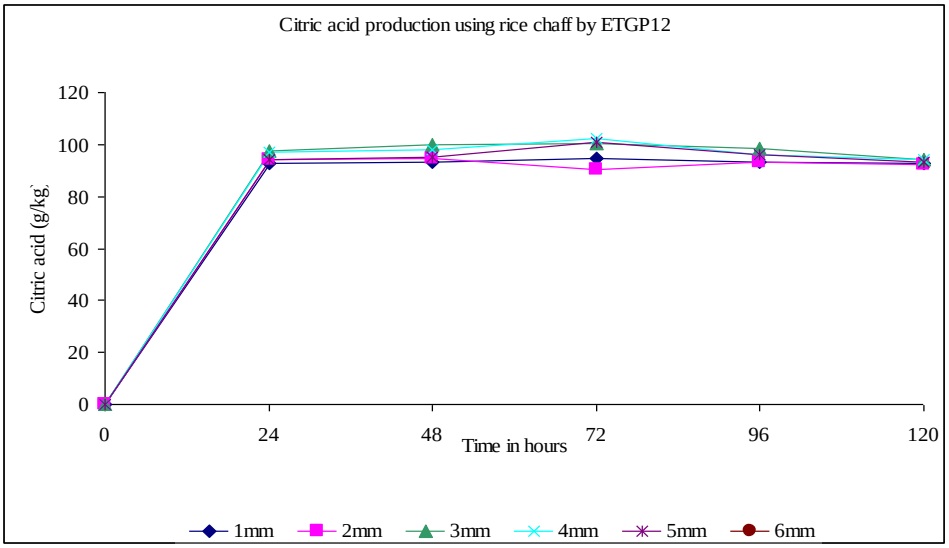

Fig.5 Production of citric acid at various particle size using rice chaff as the substrate using ETGP12 strain.

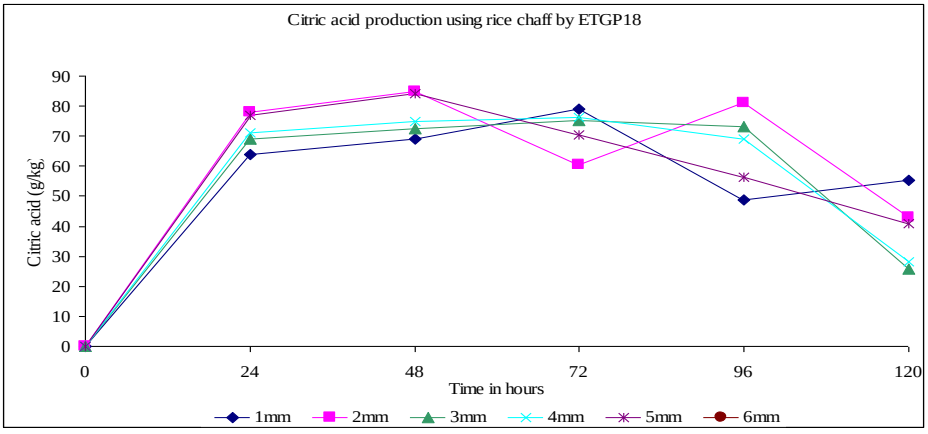

Fig.6 Production of citric acid at various particle size using rice chaff as the substrate using ETGP18

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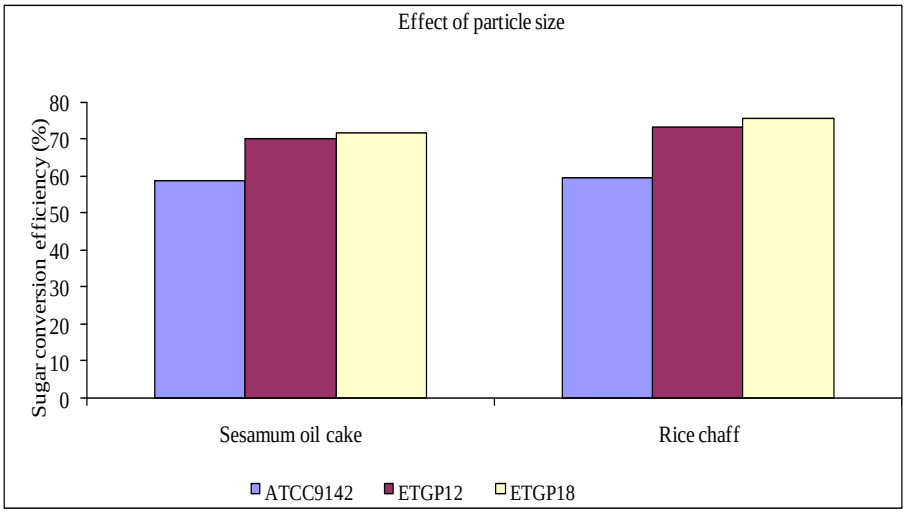

Fig.7 The particle size at which the sugar conversion efficiency observed for standard and experimental fungal strains in the substrates.

IV. CONCLUSIONS

The results from sesamum oil cake and rice chaff having different particle sizes have fermented with the strains of the *A. niger* ATCC 9142, ETGP12 and ETGP18. The yield of the citric acid by *A. niger* ATCC 9142 increased as the particle size of both the substrates increased upto 4 mm, thereafter a decrease in the yield of citric acid was observed. The maximum citric acid yields 94.8 and 102.3 g/kg were observed at particle size 4 mm and the least yield was observed at the particle size 2 mm from sesamum oil cake and rice chaff wastes. The maximum yields of citric acid obtained were 97.5 and 102.4g/kg from sesamum oil cake and rice chaff respectively. The similar set of findings were made from *A. niger* ETGP18.

REFERENCES

[1] Currie J N. The citric acid fermentation of *A. niger*, J. Biol. Chem. 31, 15; 1917.
[2] Kapoor. K. K., Choudhary, K and Tauro P., Citric acid. In; "Prescott and Dunn's Industrial Microbiology", 4th ed. (Ed: Read G) Connecticut, AVI pp 709; 1982.
[3] Rohr M, Kubicek C P and kominek J, in "Biotechnology", Ed: Dellweg H Verlag Chemie. Weinbeinm, FRG pp, 419, 1983.
[4] Milsom P E Organic acids by fermentation, especially citric acid, in *Food* Biotechnology-*1,Ed:* King R D & Cheetam P S J Applied Science, London and New York, pp 273-306, 1987.
[5] Hesseltine C W. Biotechnological report: solid state fermentations Biotechnol.Bioeng Vol 14, pp 517 – 532, 1972.
[6] Tran C T and Mitchell D A.Selection of strain of *Aspergillus* for the production of citric acid from pineapple waste in solid state fermentation. World .J.Microbiol.Biotechnol, *Vol14 (3) pp 399-404;* 1998.
[7] Lonsane B K and Ramesh M V. Bacterial thermostable alpha amylase production by solid state fermentation. *Adv. Appl. Microbial. Pp35* 1-56, 1990.
[8] Lu, M.Y., Brooks, J.D. and Maddox, I.S. Citric acid production by solid state fermentation in a packed bed reactor using *Aspergillus niger. Enzyme. Microb. Technol. Vol* 21 (6), 392-397, 1997.